## 6.10 Carr/Nisqually

1. Salmon Use

*Chinook*

This is part of the Central and South Sound region, which includes six independent populations in the Cedar-Lake Washington, Green, Puyallup, and Nisqually river systems. The Nisqually population emanates from this sub-basin.

a) Juvenile

- Juvenile Chinook salmon of all four life history types from the Nisqually natal population utilize this sub-basin for feeding and growth, refuge, physiological transition and as a migratory corridor (juvenile salmon functions).
- This sub-basin provides direct support to meeting the Chinook ESU criteria by supporting rearing of juveniles of many populations from almost all geographic regions of origin.
- Populations from south Puget Sound, particularly fish from the central Puget Sound sub-basin where most delta functions have been lost, also utilize this sub-basin for feeding and growth, refuge, physiological transition and as a migratory corridor.

b) Adult

- Adult Chinook salmon from the Nisqually natal population derive functions (i.e., feeding, migratory corridor) from this sub-basin. See Figure E-10.1 for map of other Chinook use besides the Nisqually River.
- Adult Chinook salmon from non-natal populations also utilize this sub-basin
- This sub-basin provides direct support to meeting the Chinook ESU criteria by supporting rearing of sub adults and adults of many populations from almost all geographic regions of origin.

*Other Listed Species (not comprehensively reviewed or assessed for this sub-basin)*

- Chum salmon: None of the eight populations of the Hood Canal/Eastern Strait of Juan de Fuca Summer Chum ESU targeted for recovery emanate from this sub-basin. However, summer chum populations within the ESU are documented to exist in this sub-basin in Chambers Creek and Burley Creek.
- Bull trout (anadromous): Preliminary core populations within the Puget Sound Management Unit of bull trout do not emanate from this sub-basin. However, the upper and lower Nisqually River is considered important foraging, migration, and overwintering habitat for recovering populations from the north (USFWS 2004).

2. Ecological and Landscape Conditions

Food Web, Ecological Conditions

Portions of this sub-basin exhibit poor water quality, and if not addressed or corrected, may continue to negatively affect the ecology of this sub-basin. As in the Central Puget Sound sub-basin, toxic contaminants such as PCBs and PBDEs (and others) are polluting the food web of

Puget Sound, particularly the central and south sound basins (three sub-basins: central Puget Sound, Carr-Nisqually, south Puget Sound). Natal Chinook salmon populations from the two basins as well as a primary salmon prey (i.e., Pacific herring) appear to be contaminated with toxics (see following sections for more detail). These "resident" salmon (i.e., natal populations) exhibit greater concentrations of toxics when compared to migratory salmon (i.e., non-natal populations) passing through each sub-basin.

A comprehensive approach toward restoration of the historical water quantity, nutrients, and water quality baseline pathways and patterns will likely be necessary to protect and restore ecological functions to conditions supporting viable populations in protected sub-basins with limited circulation, such as this sub-basin. Preventing further degradation of D.O. and other water quality factors including avoidance of further stormwater loadings and NPDES discharge loadings will be key. Beyond that, redirection of sewage treatment discharges to upland treatment and reuse/recharge systems will be needed to reduce summer time loadings that are degrading D.O. levels and shifting nearshore community structure (Bill Graeber, NOAA-TRT, pers. comm.).

Re-creation of the Nisqually Delta estuary represents a riverine estuary restoration potential of regional significance. Restoring the Nisqually Delta estuary represents one of only a few opportunities to recover an increment of the 70% historic loss of this habitat type in a block large enough to be a fully functional river estuary and to restore ecologic processes at the regional scale. Watershed efforts already underway on restoration of the estuary should be fully supported and further encouraged (Bill Graeber, NOAA-TRT, pers. comm.)

Landscape Conditions

The Carr-Nisqually sub-basin lies inland of a significant underwater geologic sill and tidal constriction through the Tacoma Narrows. This effects the sub-basin and neighboring South Sound sub-basin in several ways. Extreme tidal ranges can be up to 18 feet, nearly twice as large as the Strait of Juan de Fuca and San Juan Islands because of tidal pumping through the Narrows. The sill also isolates the waters of Carr-Nisqually and South Sound sub-basins so that the oceanographic residence time is considerably longer than the main basin leading to a susceptibility for nutrient pollutants to concentrate over time leading to eutrophication.

Figures E-10.1 through E-10.5 in Appendix E provide additional information about landscape conditions in this sub-basin.

*Pocket Estuary Analysis*

We identified 35 pocket estuaries in this sub-basin. This sub-basin contains a high concentration of pocket estuaries in Puget Sound (1.35 per square mile). The many pocket estuaries are distributed relatively uniformly throughout the sub-basin.

- Freshwater sources were observed in fewer than half (15) of the pocket estuaries,
- Based on the assumptions listed in Appendix B, all three of the Chinook functions (feeding, osmoregulation and refuge) were estimated were estimated to occur in 13 of the

**Overall area**

- Total area (deep-water plus nearshore) is 51,136 acres (79.9 square miles)
- Deep-water portion (marine waters landscape class) comprises 34,688 acres (54.2 square miles), or 68% of the total sub-basin area.

**Nearshore area**

- Nearshore portion comprises 16,448 acres (25.7 square miles), or 32% of the total sub-basin area. As part of the nearshore, the Nisqually estuary is a natal estuary (landscape class) for the independent Chinook population listed above, comprising 4.15 square miles (16%) of the total nearshore area within this sub-basin.
- Nearshore area within this sub-basin is 4% of the nearshore area of the entire Puget Sound basin.
- Contains 156 miles of shoreline (beaches landscape class).
- The "key" bays (landscape class) identified in this sub-basin are Chambers Bay, Taylor Bay, Oro Bay, Amsterdam Bay, Filuce Bay, Henderson Bay, Wallochet Bay, and Horsehead Bay.
- Forty-four linear miles (28%) of the shoreline is designated as marine riparian (defined as the estimated area of length overhanging the intertidal zone).
- In this sub-basin, 34% of the shoreline (53 linear miles) has eelgrass (*Zostera marina* and *Z. japonica*); may be patchy or continuous.
- In this sub-basin, 4% of the shoreline (7 linear miles) has floating kelp; may be patchy or continuous. Also in this sub-basin, 4% of the shoreline (6 linear miles) has non-floating kelp; may be patchy or continuous.
- 35 pocket estuaries. Most of the remaining pocket estuaries were estimated to have two of the three Chinook functions,
- Nineteen pocket estuaries were estimated to be *properly functioning*. Five pocket estuaries were estimated to be *not properly functioning*. The remaining 11 pocket estuaries were recorded as *at risk*.

*Drift Cell Analysis*

The drift cell characterization developed for this sub-basin is presented in Appendix E, Figure E-10.5 and subsequent text. Recommendations for protection and restoration are highlighted in Tables 6-20 and 6-21.

Threats/stressors

*Loss and/or simplification of delta and delta wetlands*

Comparison of historical wetland area and wetland area reported in Bortleson et al. (1980) revealed that for the Nisqually delta, the estimated area of subaerial wetlands decreased from historical to date of survey in 1980 from 2.20 to 1.58 square miles (decreased by 0.62 square miles). The estimated area of intertidal wetlands decreased from historical to date of survey in 1980 from 2.85 to 2.24 square miles (decreased by 0.61 square miles). The loss of lowland wetlands has not been as pronounced as in other larger estuaries to the north, and is much less developed than other large, natal estuaries. Diking for agriculture purposes is the primary reason for any loss, but in recent years some dikes have been breached (or removed) to allow for increased tidal inundation and exchange. This is expected to greatly benefit salmon and bull trout.

*Alteration of flows through major rivers*

Two dams occur on the Nisqually River, Alder dam and LaGrande dam. A natural barrier on the river is thought to have occurred in the location of LaGrande dam (USFWS 2004). Other large-scale flow alterations are not present in this sub-basin. Smaller dams and diversions likely exist but are not identified here. Diking is present in the lower river and estuary.

*Modification of shorelines by armoring, overwater structures and loss of riparian vegetation/LWD*

The projected population growth in Pierce and Thurston counties between 2000-2025 is 34% (241,337 people) and 62% (129,470 people), respectively (PSAT 2004). In this sub-basin, shoreline armoring occurs along nearly 68 miles (44%) of the shoreline. Thirty-three miles of shoreline are classified as 100% armored. Over 53 miles are classified as 0% armored. The total number of overwater structures is 1,588, consisting of ramps (177), piers and docks (346), small slips (1,058) and large slips (7). Overwater structures generally overlap with the shoreline armoring regions mentioned above, especially Hale Passage, Henderson Bay and portions of Carr Inlet. Within 300 feet of shore railroad grades occur along 16.7 miles, following the entire shoreline from the eastern edge of the Nisqually delta, north to the Tacoma Narrows bridge and beyond.

The Lowland Nisqually River exhibits a branching and multiple channel pattern and over the last 130 years, frequent channel shifts have occurred (Collins et al, 2003). Large wood jams are a critical component to maintaining the anastomosing character of the lower Nisqually River. Patches of mature forests on the floodplain of the Nisqually River still exist and contributed to the "channel-switching dynamic" of this system (Collins et al, 2003). Field data collected in 1998 showed the Nisqually River contained approximately 8 times more wood per channel width than the Snohomish and 21 times more wood than the Stillaguamish, most of the difference "accounted for by the abundance of wood in jams in the Nisqually River" (Collins et al, 2003).

*Contamination of nearshore and marine resources*

Regions with 15% or greater impervious surface are found mostly along the eastern shore from Steilacoom, north (PSAT 2004).

In this sub-basin, toxic contaminants such as PCBs in the food chain are a concern, from both past and present activities. Sediment contaminant levels were compared from 1989-1996 to levels in 2000, and revealed that the most numerous increases in PAH levels occurred on East Anderson Island, compared to other sample locations (PSWQAT 2002a).

See Figure E-10.3 for information about the distribution of water quality impairments in this sub-basin.

*Alteration of biological populations and communities*

Pacific herring have been found to be "3 to 11 times more contaminated with PCBs in central and south Puget Sound than the Strait of Georgia" (WDFW, unpublished data). These WDFW results from 2004 are similar to those reported in 1999 and 2000 in PSWQAT (2002a), where body burdens of PCBs were higher in Pacific herring from the central basin (Port Orchard) and southern Puget Sound basin (Squaxin Pass) than Pacific herring from northern Puget Sound and the Strait of Georgia. Finally, the WDFW researchers report that the PCB-contaminated food web of Puget Sound may explain the source of the PCBs identified in southern resident killer whales. See the ecological section, above, for additional information.

There are approximately 13 hatcheries releasing various salmonids into this sub-basin, which may cause alteration of community structure, competition for available prey resources and predation of wild fish. There are several commercial shellfish aquaculture operations, mostly raising Pacific (Japanese) oyster, Manilla clams and various native species. Significant recreational fishing pressure may have changed the historic community structure of fish species throughout this sub-basin. Specific hatchery reform recommendations for this region have been formulated by the Hatchery Scientific Review Group available at the following websites.
http://www.lltk.org/pdf/HSRG_Recommendations_February_2002.pdf
http://www.lltk.org/pdf/HSRG_Recommendations_March_2003.pdf

*Transformation of land cover and hydrologic function of small marine discharges via urbanization*

We identified and analyzed 35 pocket estuaries for their level of function for juvenile Chinook. Urbanization is currently stressing 8 of those pocket estuaries. Days Island and Burley lagoon were determined to be not properly functioning for juvenile Chinook. See Figure E-10.4 for a list of pocket estuaries and an indication of the stressors noted through review of oblique aerial photos.

*Transformation of habitat types and features via colonization by invasive plants*

*Spartina spp* are not found in this sub-basin. 15% of the shoreline (24 miles) contains *Sargassum muticum*, which may be patchy or continuous.

**B. Evaluation**

In this section we list goals and evaluate the level of realized function for natal and non-natal Chinook, summer chum, and bull trout. From this we then list each of the proposed protection and restoration actions for this sub-basin, and describe the benefits to natal Chinook, non-natal Chinook, and summer chum and bull trout (if any).

Goals for listed salmon and bull trout whose natal streams are in this sub-basin

a) Provide early marine support for all four life history types of the Nisqually population emanating from this sub-basin,
b) Provide support for sub-adult and adult Chinook salmon populations who utilize habitats within this sub-basin as a migratory corridor and grazing area,
c) Provide marine support for sub-adult and adult anadromous bull trout populations using the lower Nisqually as foraging, migration, and overwintering habitat,
d) Provide marine support for summer chum populations outside of the eight populations targeted for recovery (e.g., Hood Canal/Eastern Strait of Juan de Fuca)
e) Provide for connectivity of habitats; also, adequate prey resources, marine foraging areas, and migratory corridors for juvenile, sub-adult and adult Chinook, summer chum, and bull trout
f) Provide early marine support for independent spawning aggregations occurring in this sub-basin.

Goals for listed salmon and bull trout whose natal streams are outside this sub-basin

a) Provide continued support for all neighboring Puget Sound populations, specifically significant non-natal Chinook salmon use of this sub-basin by fish primarily from the main basin (juveniles, sub-adults, and adults).

Realized function for listed salmon and bull trout

Fry migrant Chinook – Over two-thirds of the pocket estuaries within five miles of the Nisqually delta are estimated to be properly functioning (Figure E-10.2) and with minimal stressors noted (Figure E-10.4). Slightly over half the pocket estuaries between five and ten miles from the Nisqually delta are estimated to be properly functioning. Fry migrants emerging from the delta in search of the shallow water, low-velocity habitats associated with pocket estuaries will find fully functioning pocket estuaries nested within somewhat protected shorelines from the western edge of the delta, stretching toward Johnson Point, as well as across Nisqually Reach to include the southern half of Anderson Island. Pocket estuaries are nearly absent along the eastern shore as fry migrants emigrate northward. This region of shoreline exhibits armored shorelines with a continuous railroad grade along the shoreline, but with a relatively unpopulated shoreline region up to Steilacoom. Connectivity between habitat types and landscape classes, including intact freshwater “lenses” (or bands) along shorelines, is essential for small-sized fry migrants emerging from the Nisqually delta in search of rearing, refuge and osmoregulatory habitats within pocket estuaries. Any disruption such as habitat fragmentation or reduction/elimination of freshwater contribution in areas between the delta and destination pocket estuaries would be detrimental to this life history type.

Delta fry Chinook – The net loss of intertidal wetlands within the Nisqually delta from historic conditions was relatively low (0.61 mile$^2$ or 395 acres) (Bortleson et al., 1980). Consequently, the opportunity for delta fry to access delta habitat is presently realized, and this is improving each year (e.g., up to 1000 acres are slated for recovery by 2006). On average, delta fry are an abundant Chinook salmon life history type in Puget Sound, entering the estuarine environment at a small size, and utilizing the myriad estuarine habitats for rearing, osmoregulatory function and predator avoidance (refuge) until reaching a size (i.e., parr migrant or larger) where they venture out to the neritic and pelagic waters of Puget Sound. As with fry migrants, connectivity between habitat types and landscape classes is essential. Delta fry moving out of the delta environment (as larger fish) can access mostly protected shorelines and properly functioning pocket estuaries to the north and northwest of the Nisqually delta. As delta fry make their way to the northern reaches of this sub-basin, the fish are exposed to several wastewater discharges and chemicals. In addition, "resident" fish from this and other sub-basins (central Puget Sound and south Puget Sound) are experiencing higher toxic contaminant body burden levels versus those salmon migrating through these sub-basins from elsewhere (WDFW, unpublished data).

Parr migrant Chinook – Many of the Puget Sound Chinook salmon migrate to the ocean as sub-yearlings (Myers et. al., 1998), and on average this life history type is the most abundant in Puget Sound. Parr migrants from the Nisqually Chinook salmon population, as well as populations from central Puget Sound, have access to pocket estuaries occurring at a rate of 1.35 per square mile throughout the sub-basin (>50% are estimated as properly functioning). Parr migrants from the Nisqually population spend anywhere from a week to a month or more in the estuary before moving out into the larger waters of the sub-basin, and beyond. Connectivity between habitat types and landscape classes is essential to this life history type. Parr migrants moving south out of the central Puget Sound sub-basin are thought to greatly utilize, and depend on the shoreline habitats within the Carr-Nisqually sub-basin. The shorelines of McNeil Island, Anderson Island and the terminus of Henderson Bay exhibit pocket estuaries either properly functioning or at risk, as well as relatively unarmored shorelines.

Yearling – Any reduction in capacity as a result of non-support of the other life history types (i.e., primarily parr migrants) within this sub-basin will negatively affect yearling migrants. Connectivity between habitat types and landscape classes is very important to yearlings from the Nisqually population, and other populations moving about broadly within Puget Sound. Yearling migrants will be exposed to the same types of stressors and ramifications as described in the other sections above. Yearling migrants can derive functions (e.g., foraging, refuge, migratory pathway) from available nearshore habitats as described above. Of concern are the toxic contaminants polluting the food web in the three southern sub-basins, and the body burden effects on salmon.

Sub-adult and adult Chinook - Larger fish migrating through this sub-basin must contend with water quality issues and toxic contaminants in the food chain. Researchers from WDFW have documented that, in general, Chinook salmon living in or migrating through Puget Sound (specifically in central and south sound) are more contaminated with PCBs than stocks outside of Puget Sound (e.g., Columbia River, WA coast). See Figure 4.7 in Section 4. Residence time in the central and southern Puget Sound basins is suspected as a "primary predictor of PCB concentration in Chinook salmon" and as such, those salmon spending the greatest amount of time in central and south sound exhibit the greatest PCB concentrations (WDFW, unpublished data) (Figure 4-8). Another toxic contaminant of concern in Puget Sound is PBDEs, a common chemical that, like PCBs, are found in greater concentrations in resident Chinook salmon versus migratory Chinook salmon.

Listed summer chum – We hypothesize that none of the eight populations of the Hood Canal/Eastern Strait of Juan de Fuca Summer Chum ESU targeted for recovery use this sub-basin. However, those populations of summer chum listed in the Salmon Use section, above, do utilize this sub-basin.

Anadromous bull trout – Bull trout have not been observed in the Nisqually River in recent years and it is not known if a remnant population persists (USFWS 2004). However, it is believed that as populations recover, the lower Nisqually River and the McAllister Creek estuary will be important to bull trout in this region of Puget Sound (specifically proximate populations to the north), as foraging, migration, and overwintering habitat (USFWS 2004).

**Table 6-20. Recommended protection actions for Carr/Nisqually**

| Protection action | Benefit to Natal Chinook | Benefit to Other (non-natal) Chinook | Benefit to summer chum, bull trout, other fish |
|---|---|---|---|
| Aggressive protect areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of the Nisqually delta | Sustained feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Sustained feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Sustained feeding, growth, refuge and migratory functions for other species |
| Protect against catastrophic events, especially any spills in the Narrows as this is a bottleneck region for migration. | Sustained growth and migratory functions | Sustained growth and migratory functions | Sustained growth and migratory functions for other species |
| Protect small tributary regions throughout the sub-basin | Sustained feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Sustained feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Sustained feeding, growth, refuge and migratory functions for other species |
| Protect functioning drift cells supporting eelgrass bands and depositional features along Anderson, McNeil, Ketron and Fox island shorelines and the Gig Harbor peninsula shoreline along the Narrows (Shoreline Protection Target Areas 3,4,8 and 9 in Figure E-10.5). Consider designating these shorelines for the highest level of protection within shoreline master programs and critical areas ordinances and pass strong policies limiting increased armoring of these shorelines and support landowner incentive programs for conservation. | Sustained feeding, growth, refuge and migratory functions | Sustained feeding, growth, refuge and migratory functions | Sustained feeding, growth, refuge and migratory functions for other species |

## Table 6-21. Recommended improvement actions for Carr/Nisqually

| Improvement action | Benefit to Natal Chinook | Benefit to Other (non-natal) Chinook | Benefit to summer chum, bull trout, other fish |
|---|---|---|---|
| Add enhanced treatment for stormwater discharging directly to Puget Sound to the same standards as for salmon bearing streams. | Improved feeding, growth, osmoregulation and refuge, reduced mortality | Improved feeding and refuge | Improved feeding and refuge for other species |
| Consider wastewater reclamation and reuse retrofits for McNeil Island and Solo Point discharges. | Improved feeding, growth, osmoregulation and migratory functions, reduced mortality | Improved feeding and migratory functions | Improved feeding and migratory functions for other species |
| Aggressively promote shellfish environmental codes of practice. | Improved feeding, refuge and migratory functions | Improved feeding, refuge and migratory functions | Improved feeding, refuge and migratory functions |
| Aggressive restore areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of the Nisqually delta | Improved feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Improved feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Improved feeding, growth, refuge and migratory functions for other species |
| Continue to restore the Nisqually delta - up to 1000 acres should be restored within the next couple years | Improved feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Improved feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Improved feeding, growth, refuge and migratory functions for other species |
| Retrofit the railroad grade from the Nisqually River to Point Defiance to address access to blocked pocket estuaries. Remove the separation of upland and aquatic environments | Improved feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Improved feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Improved feeding, growth, refuge and migratory functions for other species |
| Increase the tidal prism of the Nisqually delta through dike removal and elevation of Interstate 5 across the freshwater tidal portions of the delta. | Improved feeding, growth, refuge, osmoregulation and migratory functions for Nisqually population | Improved feeding, growth, refuge and migratory functions for other populations, especially Main Basin populations | Improved feeding, growth, refuge and migratory functions for other species |
| Conduct limited beach nourishment on a periodic basis to mimic the natural sediment transport processes in select sections where corridor functions may be impaired (Shoreline Restoration Target Areas 1, 2,5, 6 and 7 in Fig. E-10.5). | Improved feeding, growth, refuge and migratory functions | Improved feeding, growth, refuge and migratory functions | Improved feeding, growth, refuge and migratory functions for other species |
| Encourage voluntary re-vegetation of cleared residential shorelines throughout the sub-basin. | Improved feeding, growth, refuge and migratory functions | Improved feeding, growth, refuge and migratory functions | Improved feeding, growth, refuge and migratory functions for other species |